1.0 INTRODUCTION

This manual contains procedures for collecting samples and measurement data from selected biotic and abiotic components of streams in the eastern United States for the Wadeable Streams Assessment. These procedures were initially developed and used between 1993 and 2003 in research studies of the U.S. Environmental Protection Agency's (EPA) Environmental Monitoring and Assessment Program (EMAP), and published in Lazorchak et al. (1998) and modified by Peck et al. (2003) for use on an extensive pilot study in the western United States (EPA Regions 8, 9, and 10). The purposes of this manual are to: (1) Document the procedures used in the collection of field data and various types of samples for the Wadeable Streams Assessment (WSA) and (2) provide these procedures for use by other groups implementing stream monitoring programs similar to WSA and these procedures.

These procedures are designed for use during a 1-day visit by a crew of two or three persons to sampling sites located on smaller, wadeable streams (generally stream order 1 through 3, or higher for semi-arid and arid regions of the U.S.). They were initially developed based on information gained from a workshop of academic, State, and Federal experts (Hughes, 1993), and subsequent discussions between aquatic biologists and ecologists within the EPA Environmental Monitoring and Assessment Program (EMAP), with scientists of the U.S. Geological Survey National Water Quality Assessment Program (NAWQA), with biologists from the U.S. Fish & Wildlife Service, and with State and Regional biologists within EPA Region 3. EMAP staff has also sought information from various Federal and State scientists in the western U.S to refine these procedures.

1.1 Overview of the Wadeable Streams Assessment Program

Recent critiques of water monitoring programs have claimed that EPA and states cannot make statistically valid inferences about water quality and ecological condition, and lack data to support management decisions regarding the Nation's aquatic resources. These critiques have stemmed from reviews of the General Accounting Office (2000), the National Research Council (2001), the National Academy of Public Administration (2002), the Heinz Center Report (2002), and most recently, the draft Report on the Environment (2003). The primary reasons for this inability to produce adequate reporting of ecological condition are (1) the targeted monitoring designs used by water quality agencies, which are not conducive to extrapolation to comprehensive coverage, and (2) the question of comparability of the ecological data gathering tools, which, to date, have precluded aggregating data and/or assessments for regional and national scales.

The WSA intends to maximize partnerships among EPA, states and tribes, and other agencies to use the best combination of monitoring tools and strategies to answer key environmental questions at national, and regional scales, and to establish a framework to address issues at state and local scales. EPA's strategy for effectively targeting water quality actions that maximizes benefits and saves costs focuses on four key aspects, i.e., strengthen state programs, promote partnerships, use multiple monitoring tools, and expand accessibility and use of data.

The basic intent of the WSA is to build upon previous large-scale programs, such as EMAP and NAWQA, and to benefit from existing state agency expertise and knowledge of aquatic resources. Randomly generated sampling locations will enable assessment and reporting at regional scales (e.g., level 2 ecoregion, EPA region). Standard operating procedures (SOPs) and a strict quality assurance (QA) program will be used to ensure data integrity for the assessments. The data collection from approximately 1000 stream sites in the western United States (EPA Regions 8-10) over a 5-year period (2000 to 2004) will be complemented by a scheduled sampling of 500 stream sites in 2004 throughout EPA Regions 1-7 (Figure 1-1). A report summarizing the results of the WSA and Western Streams Studies to Congress is scheduled for December 2005.

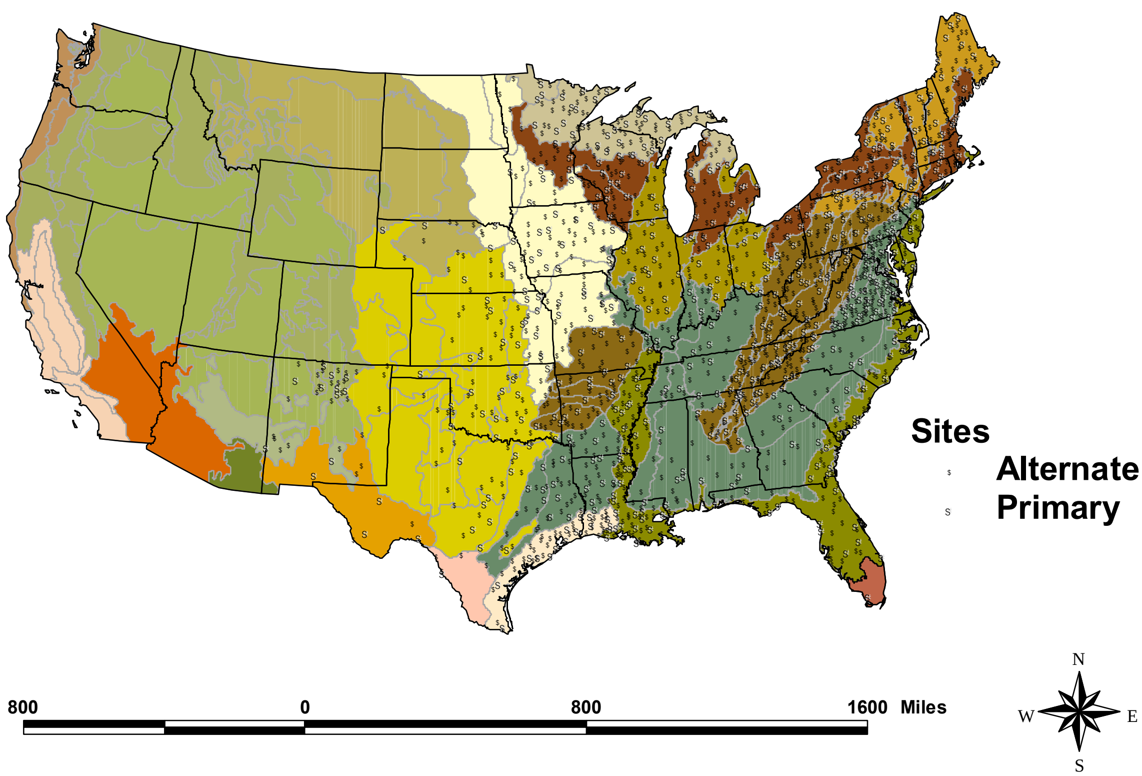

Figure 1-1. The geographic scope of the =Wadeable Streams Assessment (WSA), Level 2 ecoregions are shown.

1.2 INTEGRATION WITH THE EMAP WESTERN STUDY

A major geographic study within EMAP has targeted the states and tribal nations in the western conterminous U.S (Regions 8, 9, 10) and conducted over the past four years. Details regarding this research initiative can be found in the peer-reviewed research plan (U.S. EPA, 2000). The purpose for this western study was to further advance the science of monitoring and to demonstrate the application of core tools from EMAP in monitoring and assessment across the west. When the analyses and report are complete, the western geographic study will serve to advance both the science of monitoring and the application of monitoring to policy, provide an opportunity to push the science and its application to new levels, both in terms of the type of systems addressed (mountainous and arid systems) and the size of the region covered (essentially one third of the conterminous U.S), and demonstrate the application of EMAP designs in answering the urgent and practical assessment questions facing the western EPA Regional Offices, while framing these unique studies in a methodology that can be extended to the entire nation. WSA builds upon this framework and completes the extension of the ecological assessment country-wide.

The primary objectives of the Western Pilot Study (EMAP-WP), the surface waters component of the Western Geographic Study, are to:

1. Develop the monitoring tools (biological indicators, stream survey design, estimates of reference condition) necessary to produce unbiased estimates of the ecological condition of surface waters across a large geographic area (or areas) of the West; and
2. Demonstrate those tools in a large-scale assessment.

The goal of EMAP-WP is to provide answers to three general assessment questions:

1. What proportion of stream and river miles in the western U.S. are in acceptable (or poor) biological condition?
2. What is the relative importance of potential stressors (habitat modification, sedimentation, nutrients, temperature, grazing, timber harvest, etc.) in streams and rivers across the West?; and
3. What stressors are associated with streams and rivers in poor biological condition?

The resource population of interest for EMAP-WP are all perennial streams and rivers as represented in EPA's River Reach File (RF3), with the exception of the "Great Rivers" (the Columbia, Snake, Colorado and Missouri Rivers). The pilot study utilized an EMAP probability design to select sites which are statistically representative of the resource population of interest. This allows an extrapolation of ecological results from the sites sampled to the entire population. A comprehensive set of ecological indicators were implemented in a coarse survey of streams and rivers across all of the West (the conterminous portions of EPA Regions 8, 9 and 10). Sample sizes (i.e., numbers of stream sites) were chosen to allow eventual estimates of condition to be made for each state, numerous aggregated ecological regions (e.g., mountainous areas of the Pacific states, the Southern Basin and Range), major river basins, and many other potential geographic classifications. This survey design is more detailed than will be used in the WSA. However, the integration of EMAP-WP with the planned sampling of the eastern US will enable a first-time assessment of the ecological condition of the nation's streams at a regional scale.

1.3 SUMMARY OF ECOLOGICAL INDICATORS

The following sections describe the rationale for each of the ecological indicators currently included in the stream sampling procedures presented in this manual. Evaluation activities to determine the suitability of individual indicators to robustly determine ecological condition are ongoing at this time. This information is presented to help users understand the various field procedures and the significance of certain aspects of the methodologies.

Consistent with EMAP and state water quality agencies, two principal types of indicators, condition and stressor (U.S. EPA, 1998) will be considered in the WSA. Condition indicators are biotic or abiotic characteristics of an ecosystem that can provide an estimate of the condition of an ecological resource with respect to some environmental value, such as biotic integrity. Stressor indicators are characteristics that are expected to change the condition of a resource if the intensity or magnitude is altered.

1.3.1 Water Chemistry

Data are collected from each stream for a variety of physical and chemical constituents. Information from these analyses is used to evaluate stream condition with respect to stressors such as acidic deposition, nutrient enrichment, and other inorganic contaminants. In addition, streams can be classified with respect to water chemistry type, water clarity, mass balance budgets of constituents, temperature regime, and presence of anoxic conditions. Examples of relationships between stream chemistry and watershed-level land use data are described in Herlihy et al. (1998).

1.3.2 Physical Habitat

Naturally occurring differences among surface waters in physical habitat structure and associated hydraulic characteristics contributes to much of the observed variation in species composition and abundance within a zoogeographic province. The structural complexity of aquatic habitats provides the variety of physical and chemical conditions to support diverse biotic assemblages and maintain long-term stability. Anthropogenic alterations of riparian areas and stream channels, wetland drainage, grazing and agricultural practices, and stream bank modifications such as revetments or development, generally act to reduce the complexity of aquatic habitat and result in a loss of species and ecosystem degradation.

Stressor indicators derived from data collected about physical habitat quality will be used to help explain or characterize stream condition relative to various condition indicators. Important attributes of physical habitat in streams are channel dimensions, gradient, substrate characteristics; habitat complexity and cover; riparian vegetation cover and structure; disturbance due to human activity, and channel-riparian interaction (Kaufmann, 1993). Overall objectives for this indicator are to develop quantitative and reproducible indices, using both multivariate and multimetric approaches, to classify streams and to monitor biologically relevant changes in habitat quality and intensity of disturbance. Kaufmann et al. (1999) discuss procedures for reducing EMAP field habitat measurements and observations to metrics that describe channel and riparian habitat at the reach scale.

1.3.3 Benthic Macroinvertebrate Assemblage

Benthic macroinvertebrates inhabit the sediment or live on the bottom substrates of streams. The macroinvertebrate assemblages in streams reflect overall biological integrity of the benthic community, and monitoring these assemblages is useful in assessing the status of the water body and discerning trends. Benthic communities respond differently to a wide array of stressors. As a result of this, it is often possible to determine the type of stress that has affected a benthic macroinvertebrate community (Plafkin et al., 1989; Klemm et al., 1990; Barbour et al. 1999). Because many macroinvertebrates have relatively long life cycles of a year or more and are relatively immobile, macroinvertebrate community structure is a function of past conditions.

The basic approach to developing ecological indicators based on benthic invertebrate assemblages is to identify different structural and functional attributes of the assemblage that will serve as endpoints for measuring differences in condition. Individual attributes or metrics that respond to different types of stressors are compared against expectations under conditions of minimal human disturbance (Kerans and Karr 1994, Fore et al. 1996, Barbour et al. 1995; 1996, Wright 1995, Norris 1995). Secondly, indicators of condition based on multivariate analysis of benthic assemblages and associated abiotic variables will be examined. A data analysis plan will be developed in consultation with a technical experts workgroup.

1.4 OBJECTIVES AND SCOPE OF THE FIELD OPERATIONS MANUAL

The field-related sampling and data collection activities in this manual are organized to follow the sequence of field activities during the 1-day site visit. Section 2 presents a general overview of all field activities. Section 3 presents those procedures that are conducted at a “base” location before and after a stream site visit. Section 4 presents the procedures for verifying the site location and defining a reach of the stream where subsequent sampling and data collection activities are conducted. Sections 5 through 9 describes the procedures for collecting samples and field measurement data for various condition and stressor indicators. Specific procedures associated with each indicator are presented in standalone tables that can be copied, laminated, and taken into the field for quick reference. Section 10 describes the final activities that are conducted before leaving a stream site. Appendix A contains a list of all equipment and supplies required by a crew to complete all field activities at a stream. Field teams are required to keep the field operations and methods manual available in the field for reference and to address questions pertaining to protocols that might arise.

1.5 QUALITY ASSURANCE

Large-scale and/or long-term monitoring programs such as those envisioned for WSA require a rigorous QA program that can be implemented consistently by all participants throughout the duration of the monitoring period. QA is a required element of all EPA-sponsored studies that involve the collection of environmental data (Stanley and Verner, 1986). A QA project plan was prepared for the WSA and distributed to all participants. The QA project plan contains more detailed information regarding QA/QC activities and procedures associated with general field operations, sample collection, measurement data collection for specific indicators, laboratory operations, and data reporting activities.

Quality control (QC) activities associated with field operations are integrated into the field procedures. Important QC activities associated with field operations include a comprehensive training program that includes practice sampling visits, and the use of a qualified museum facility or laboratory to confirm any field identifications of biological specimens.

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